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TITLE: Initiating localized deformation in the mantle *(Invited)*

AUTHORS (FIRST NAME, LAST NAME): Philip A Skemer[1], Jessica M Warren[2], Lars N Hansen[2], Greg Hirth[3], Peter B Kelemen[4]

INSTITUTIONS (ALL): 1. Washington University St Louis, Saint Louis, MO, United States.
2. Stanford University, Stanford, CA, United States.
3. Brown University, Providence, RI, United States.
4. Columbia University LDEO, Palisades, NY, United States.

ABSTRACT BODY: Shear localization is a key feature of mantle deformation, particularly along plate boundaries. However the physical bases for localized deformation are not well understood. Geologically, mantle shear zones are often identified on the basis of fine-grained, weakly textured, mylonitic microstructures. These microstructural observations are interpreted as evidence that dynamic recrystallization, grain-size reduction, and the associated transition to grain-size sensitive deformation is the predominant strain-weakening process in mantle rocks. However, there are a number of other plausible strain-weakening mechanisms that may play a role in the initiation and evolution of shear zones, including compositional gradients, texture development, and viscous shear heating . In this contribution we evaluate each of these mechanisms in the context of shear zones from the Josephine Peridotite, Oregon, US. Field measurements are used to construct strain profiles across several shear zones, which demonstrate that weakening occurred over short length scales (2-60 m). Measurements of water concentration in nominally anhydrous minerals show that gradients in water concentration exist on a 10-100m scale, giving rise to spatial variations in viscosity of up to a half order of magnitude. These water concentration measurements are also correlated with the locations of shear zones and the observed olivine CPO. Using empirical flow laws we model the formation of mantle shear zones using water concentration variation to generate perturbations in the strain field. We also include in the models the effect of viscous anisotropy due to the progressive re-orientation of olivine CPO. Other weakening mechanisms are considered, but ruled out on the basis of petrology or microstructure. We conclude that several serial weakening mechanisms are required to both initiate shear localization and produce steady-state, long lived weakening in Earth's mantle.

KEYWORDS: 8012 STRUCTURAL GEOLOGY High strain deformation zones.

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Additional Details

Previously Presented Material:

Contact Details

CONTACT (NAME ONLY): Philip Skemer

CONTACT (E-MAIL ONLY): pskemer@wustl.edu

TITLE OF TEAM:
